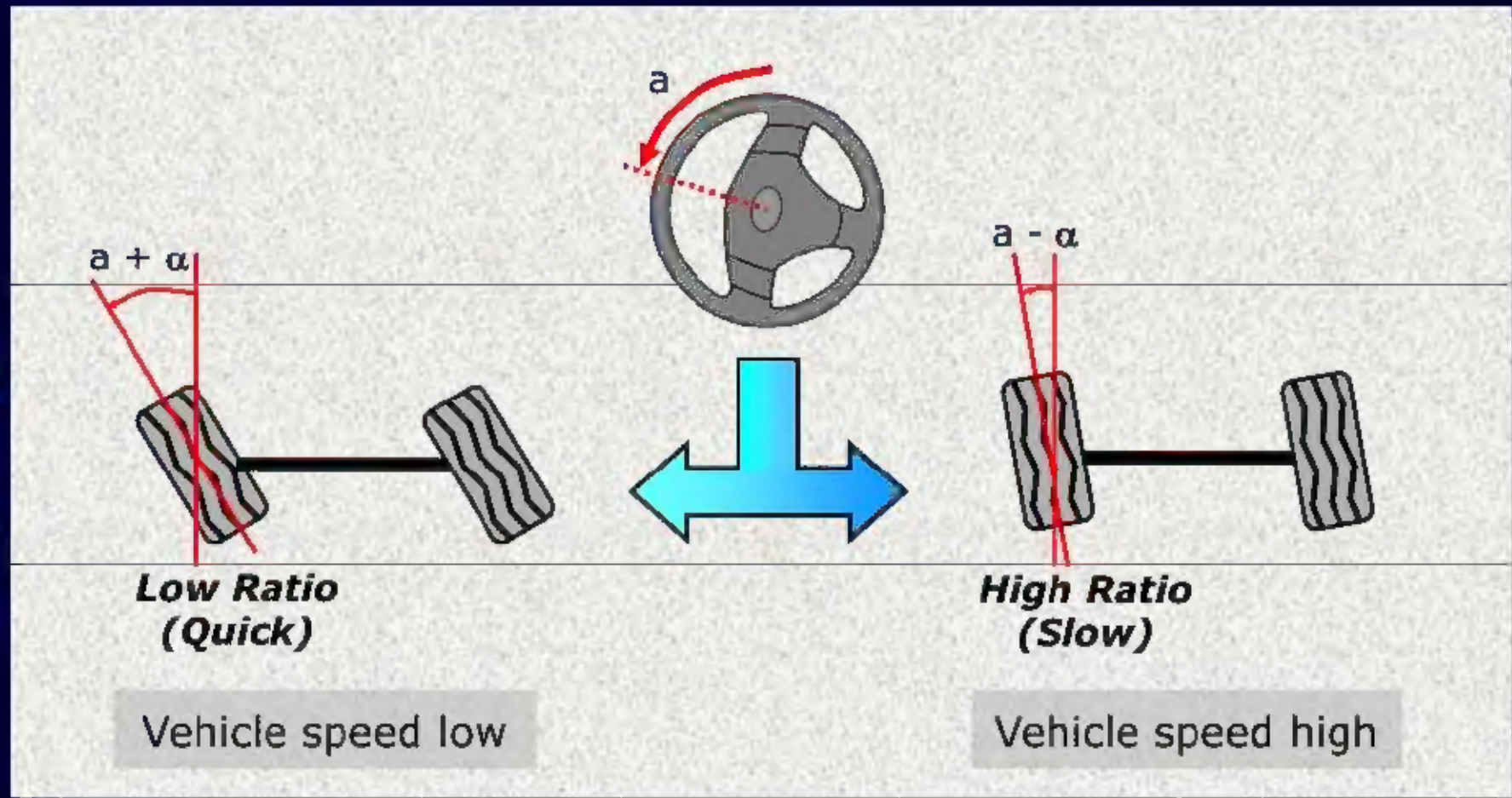


## **VGRS (Variable Gear Ratio Steering) System**

### ● General

- The steering gear ratio will be changed in accordance with the vehicle speed



## **VGRS System**

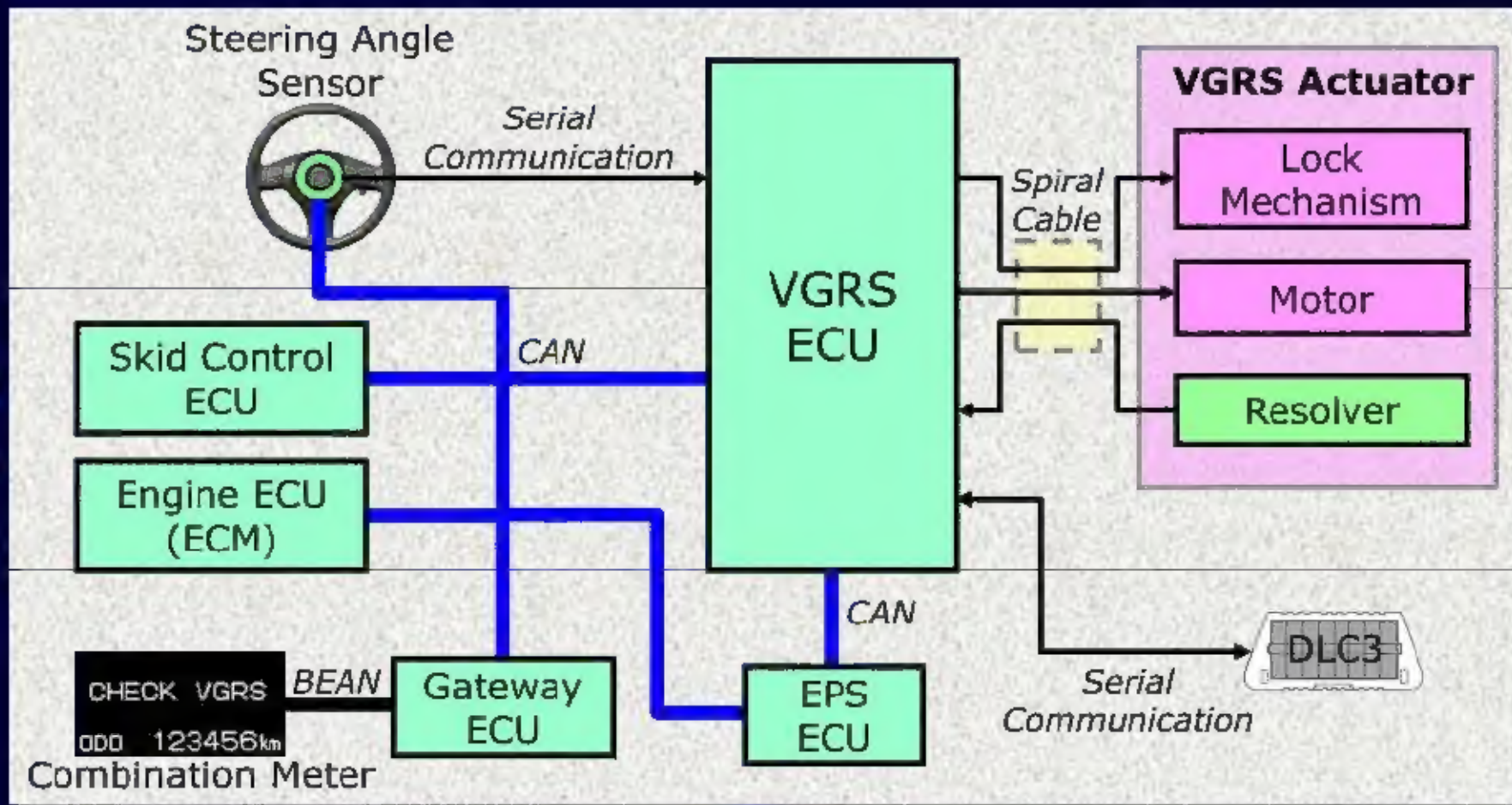
### ● Major Difference from '05 LX470

Item	'06 GS430	'05 LX470
Rotational Position Sensor (for motor)	Resolver	Three Hall ICs
System Warning	Warning Message	VGRS Warning Light
Communication	CAN, Serial Communication	Serial Communication



# VGRS System

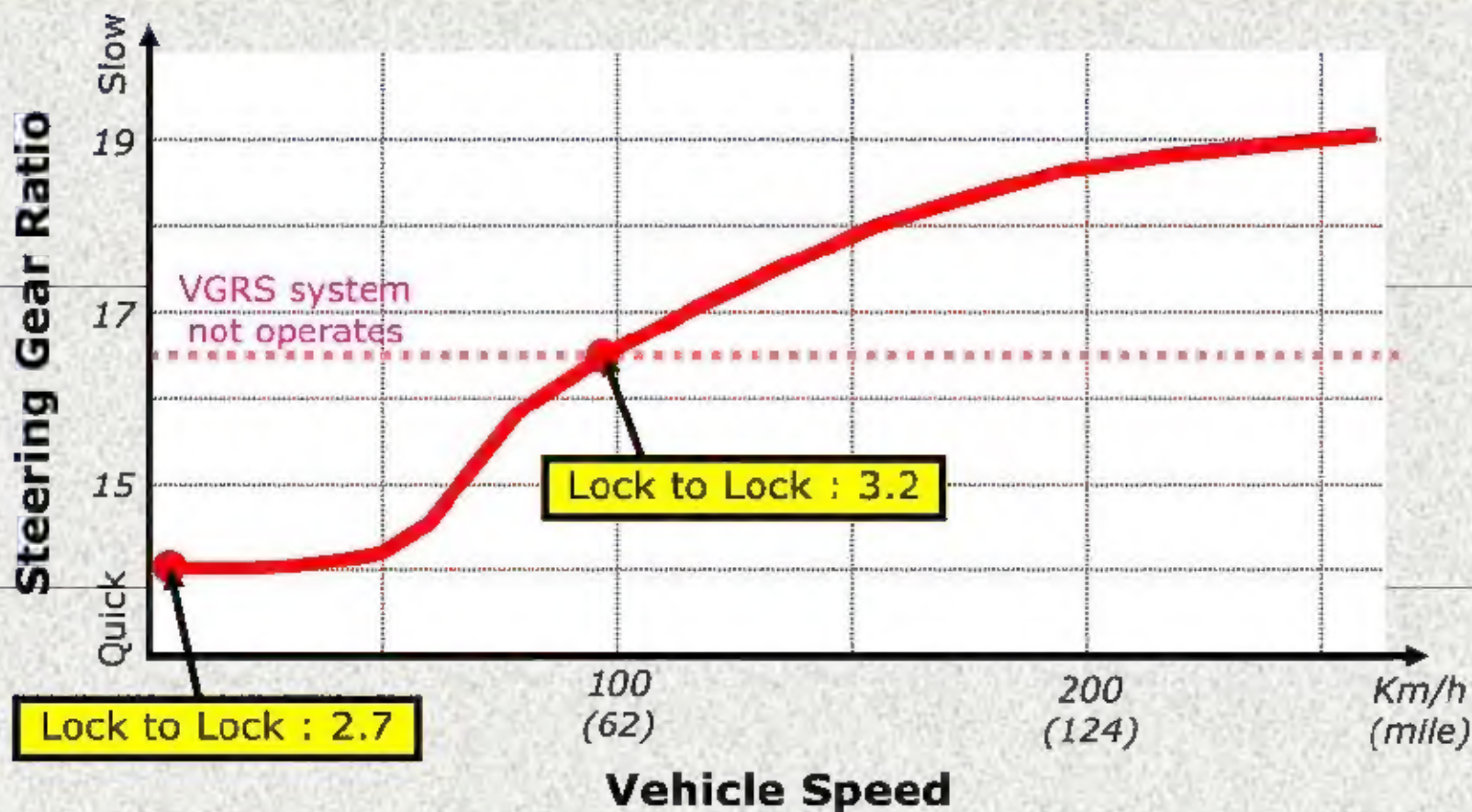
## System Diagram



## VGRS System

### Steering Gear Ratio

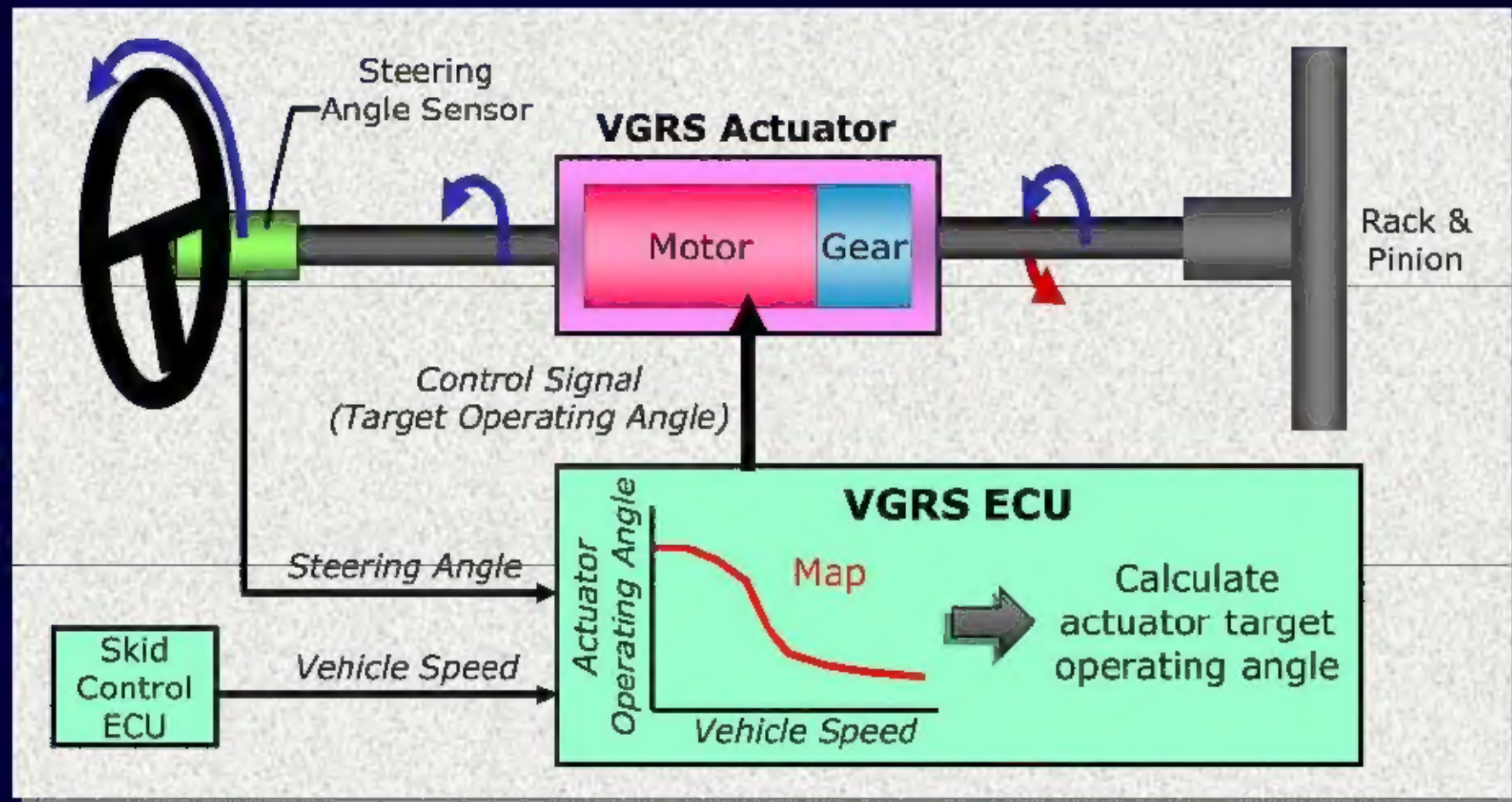
**Confidential**





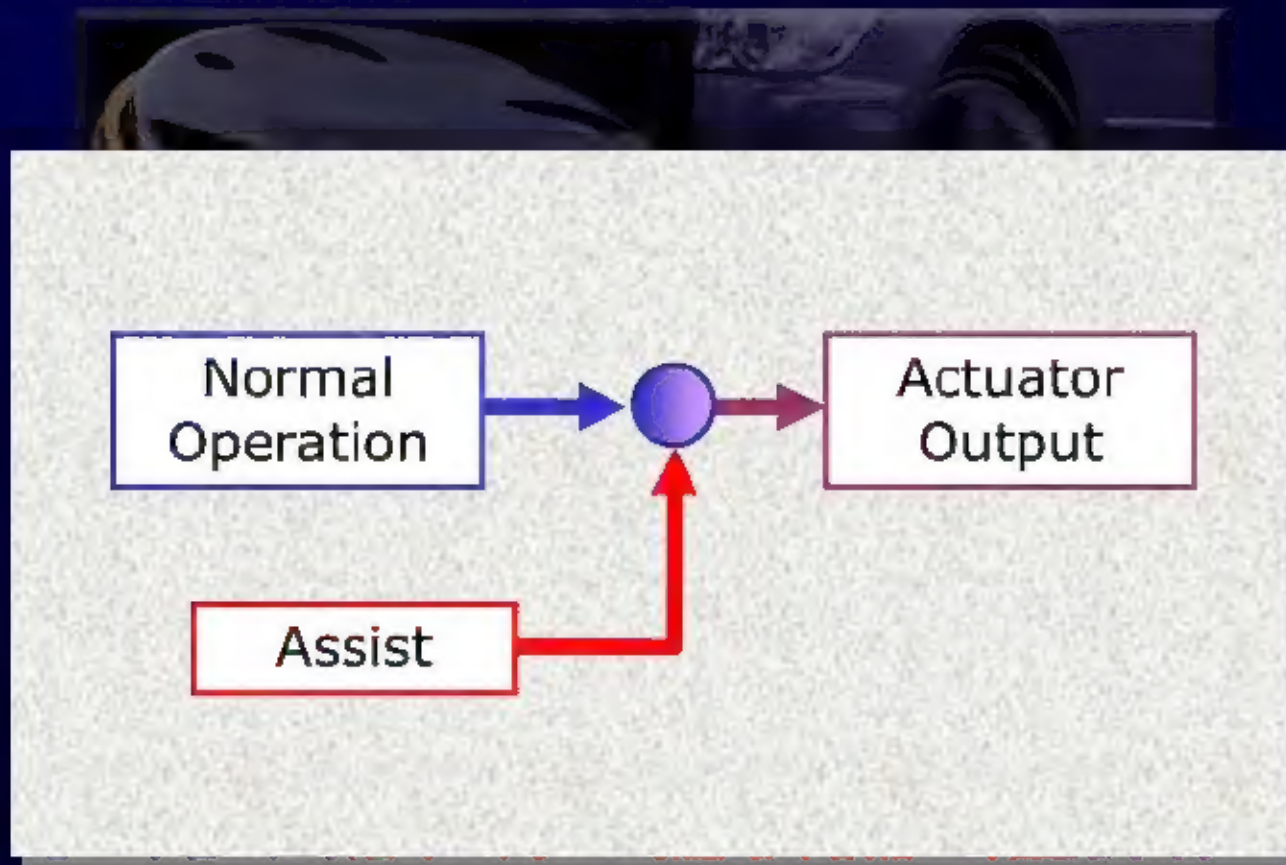
# **VGRS System**

## ● System Operation



## **VGRS System**

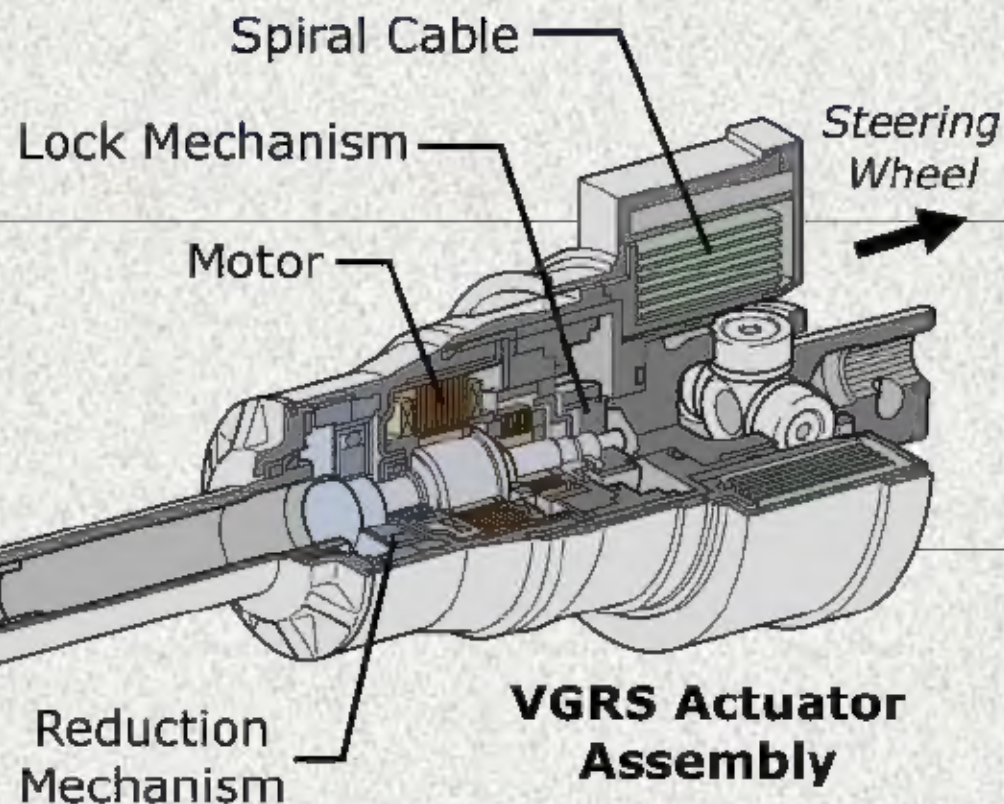
- System Operation
  - VGRS ECU adds the supplemental assist with steering speed to reduce delay of vehicle response





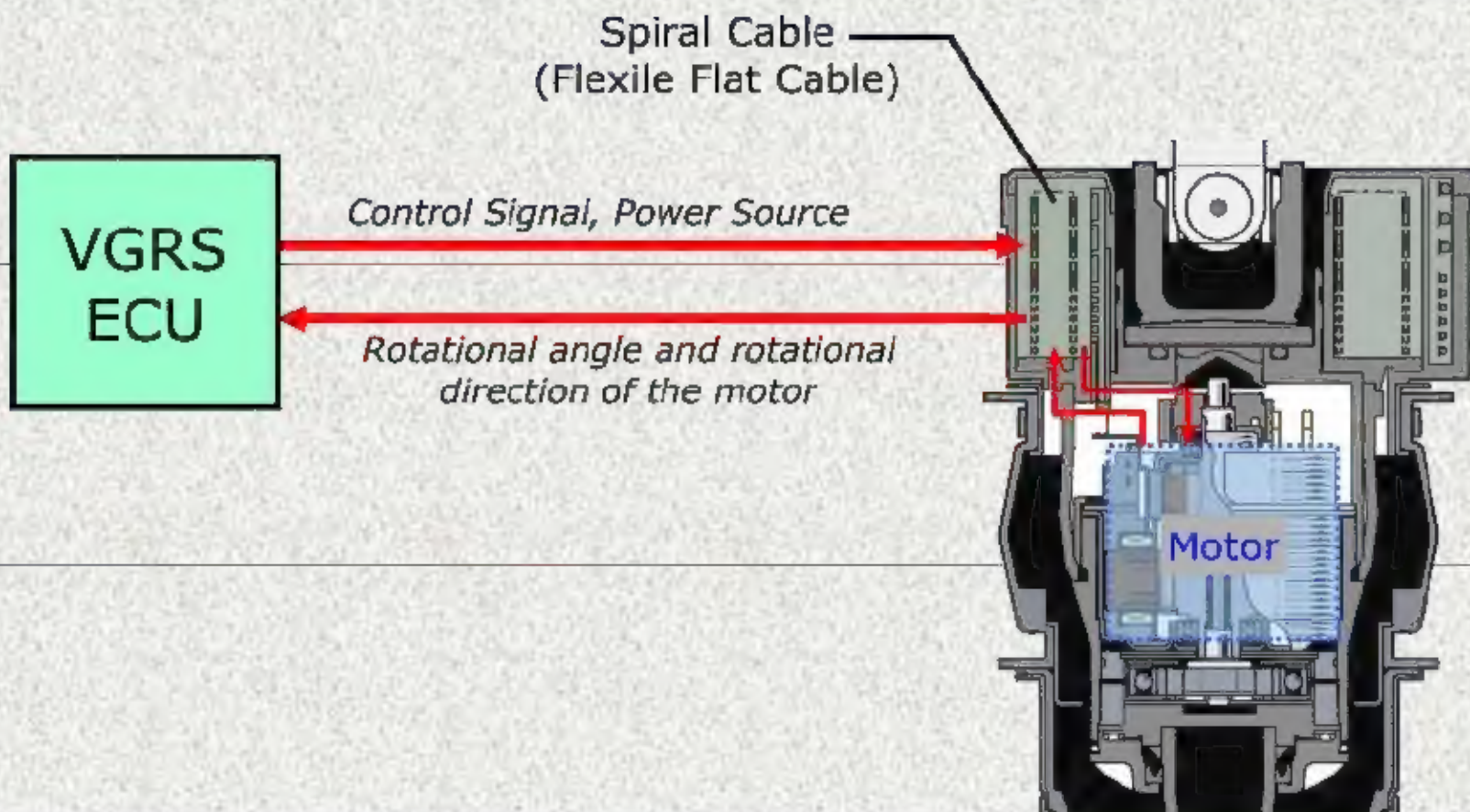
# **VGRS System**

## ● VGRS Actuator



## VGRS System

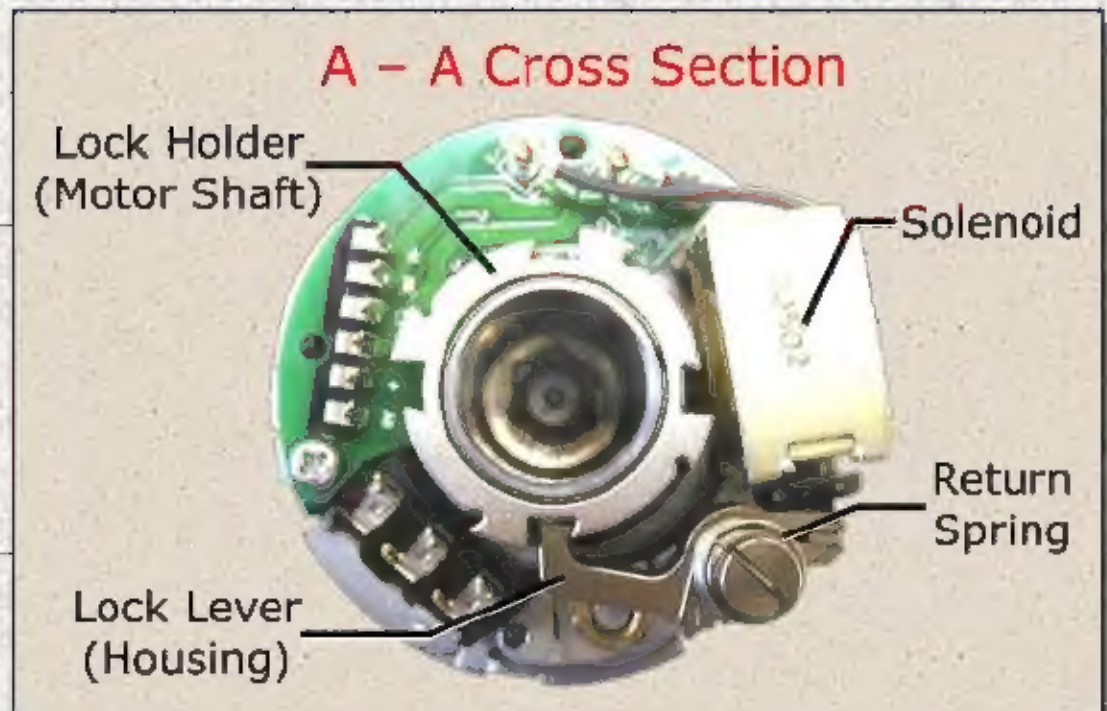
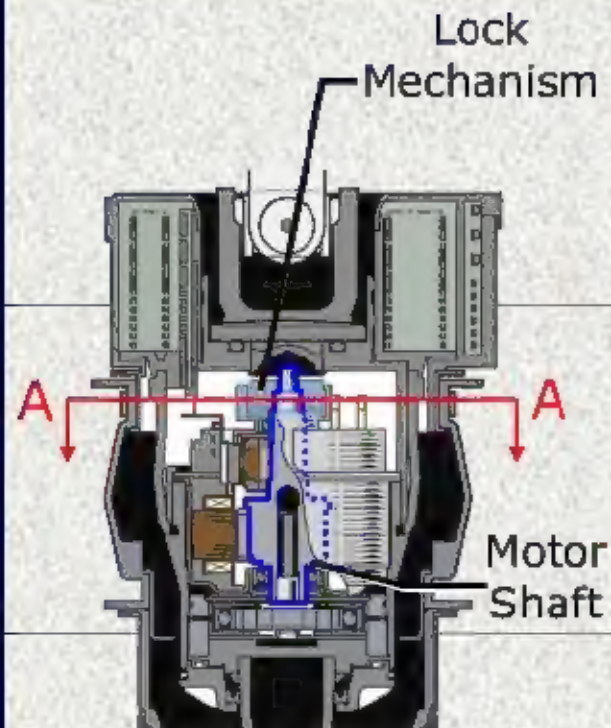
- Spiral Cable
  - Flexible flat cable is used





## VGRS System

- Lock Mechanism
  - Locks the motor shaft



## **VGRS System**

- Lock Mechanism
  - Lock / unlock operation

**Solenoid "ON"**



**Solenoid "OFF"**

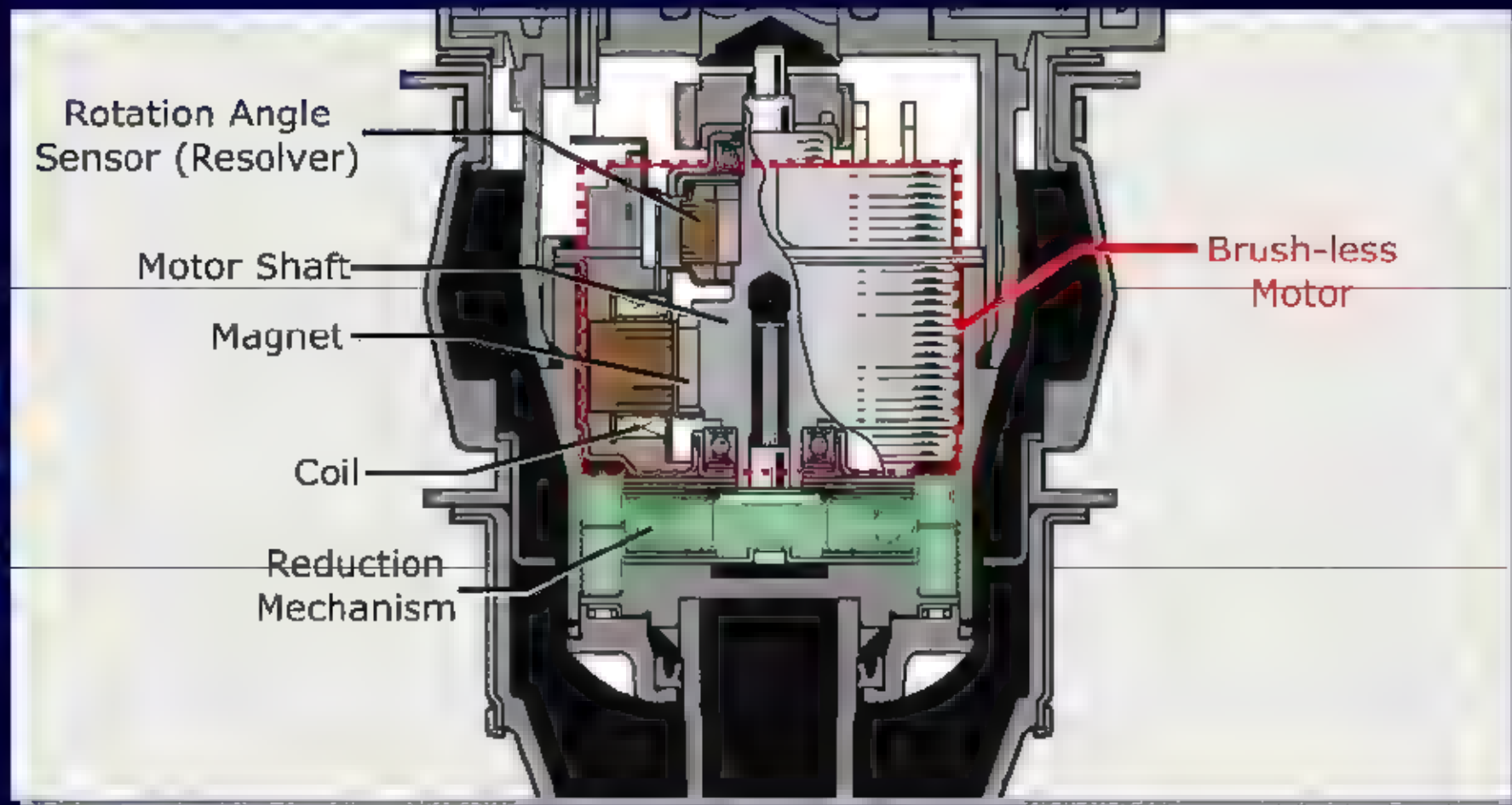




## **VGRS System**

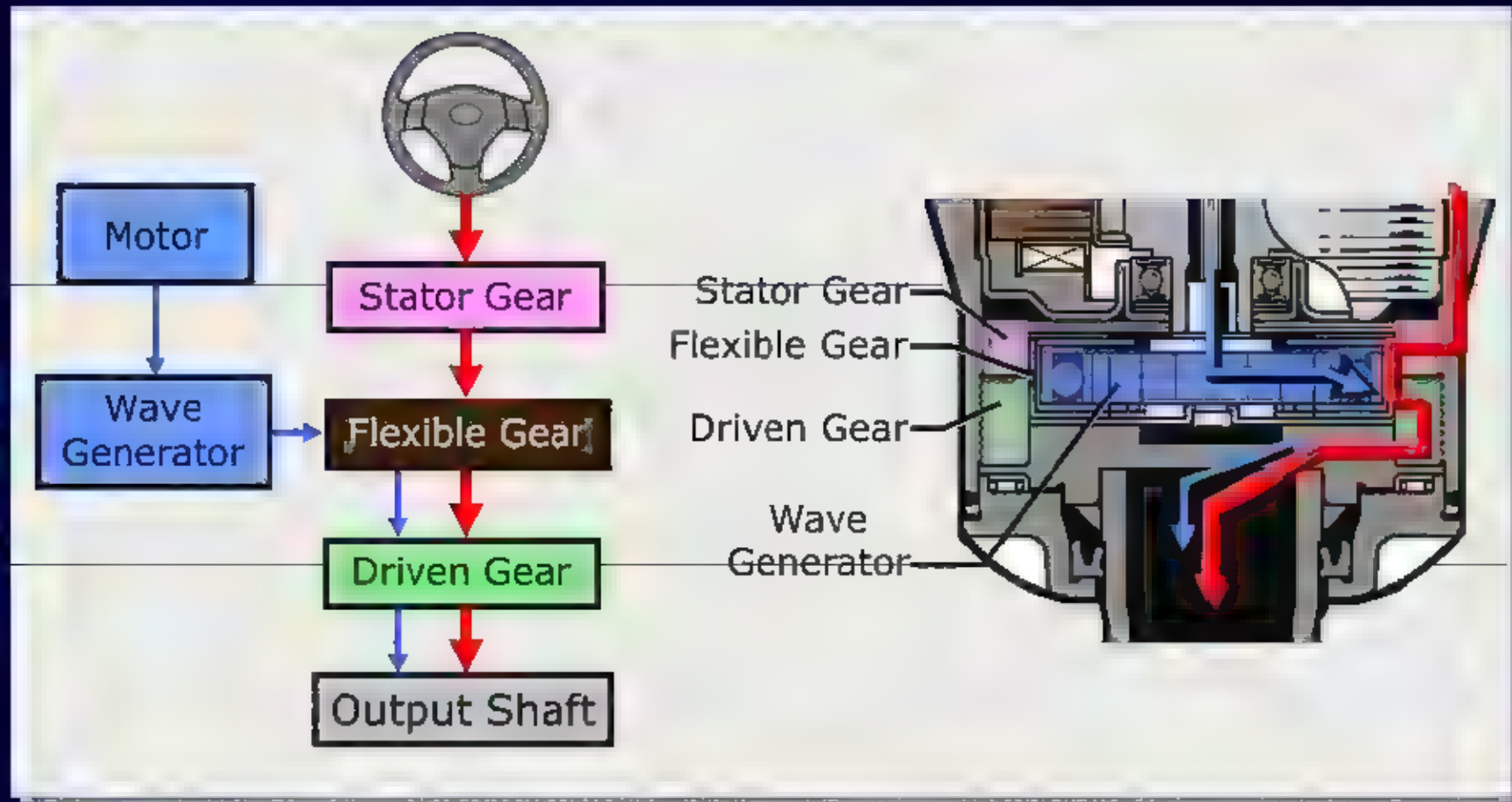
### ● Motor

- A compact high-output low-noise brush-less motor



## VGRS System

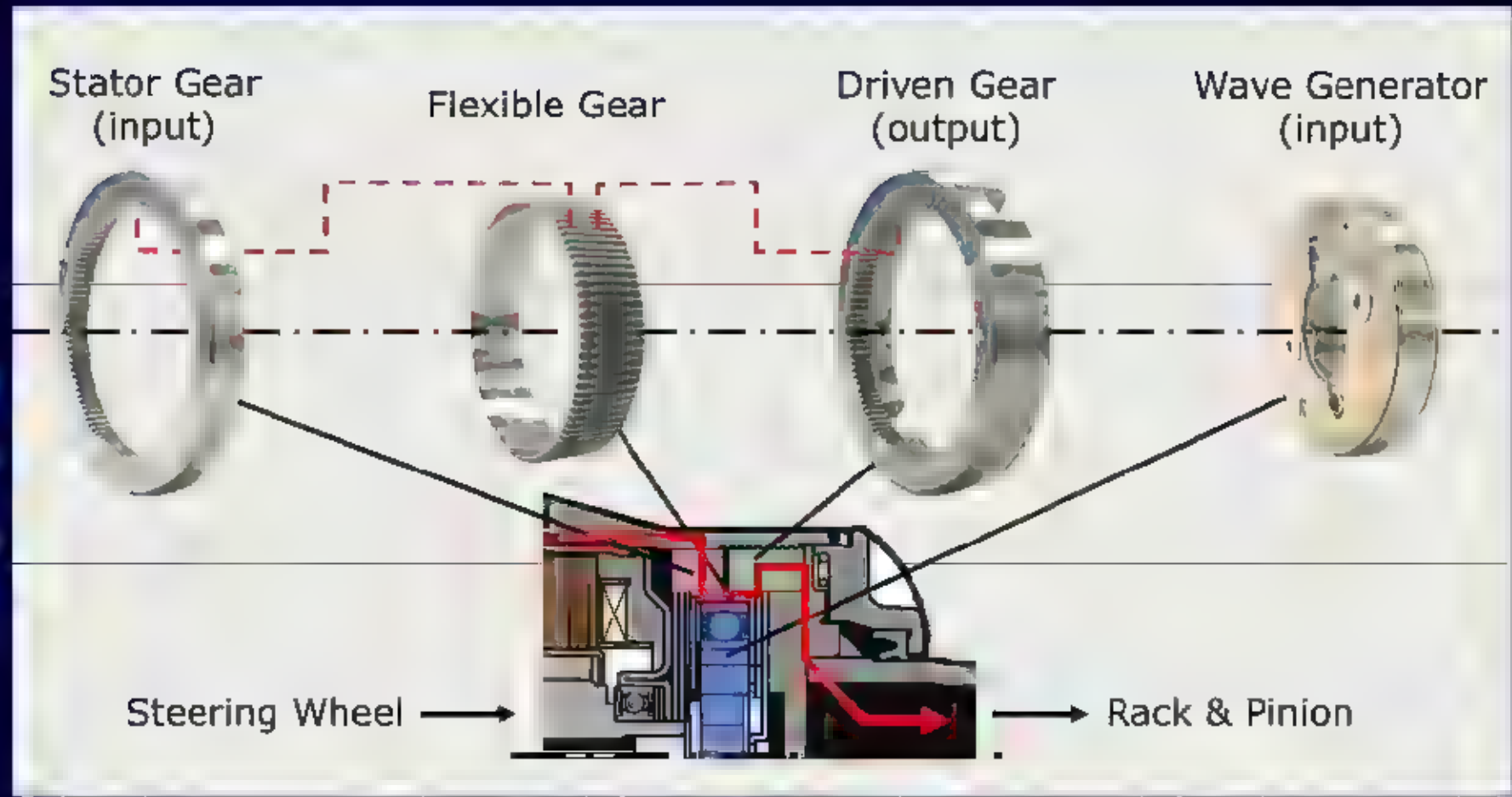
- Reduction Mechanism
  - The strain wave gearing type reduction mechanism





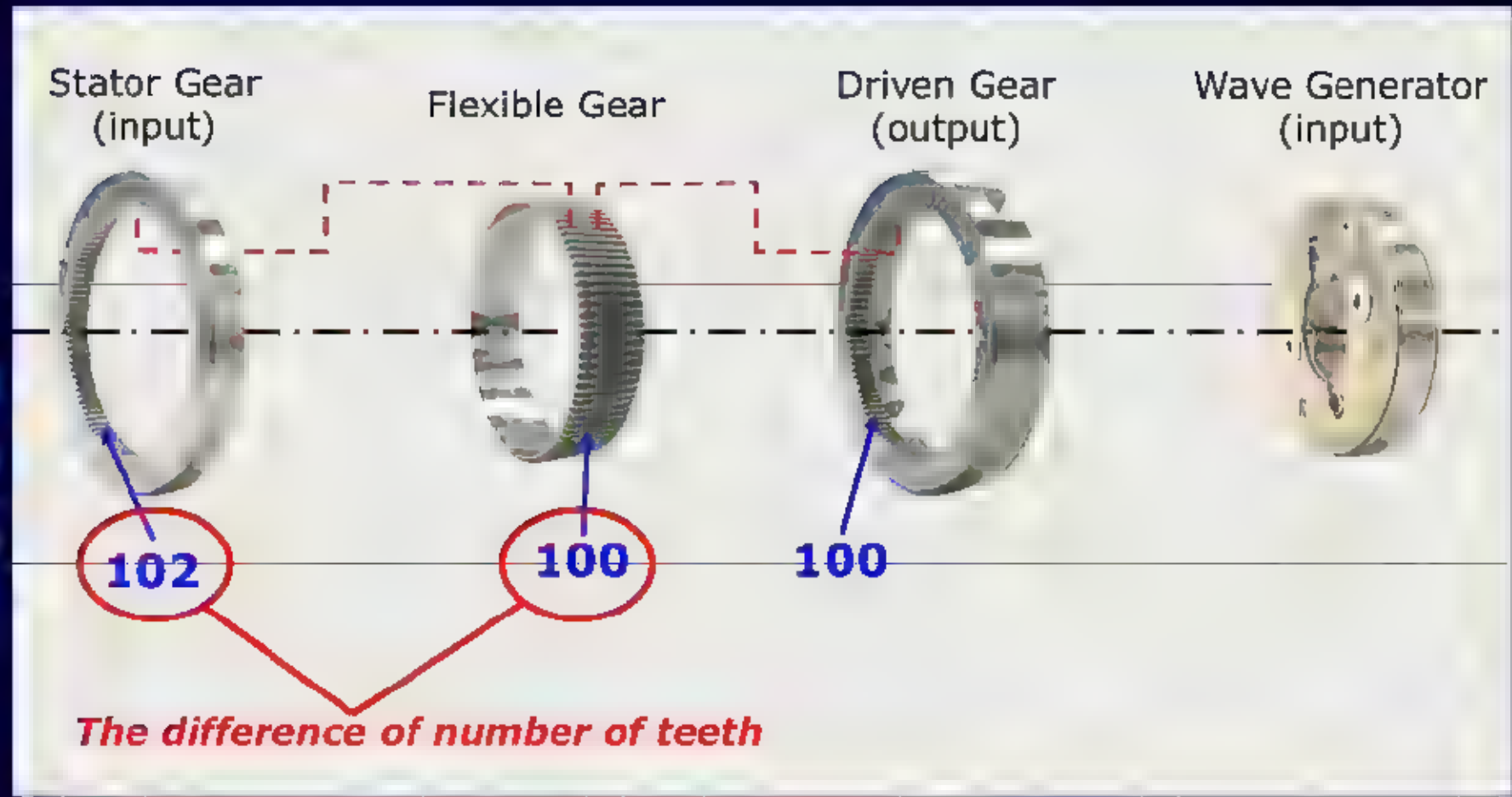
## **VGRS System**

- Reduction Mechanism
  - Components



## **VGRS System**

- Reduction Mechanism
  - Number of teeth





## VGRS System

- Reduction Mechanism – Construction



Stator Gear

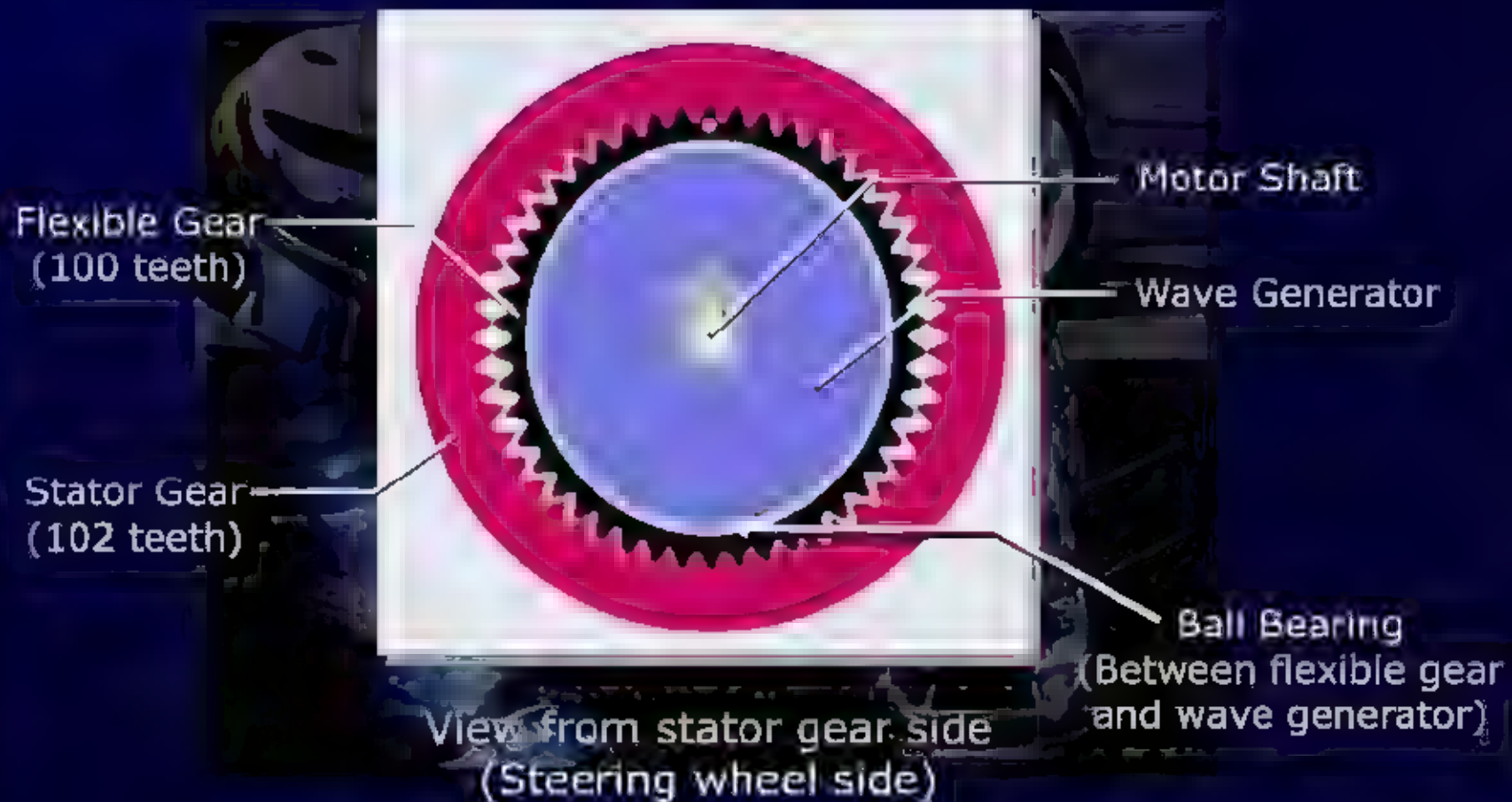
Flexible Gear

Wave Generator

Ball Bearing is  
between flexible gear  
and wave generator

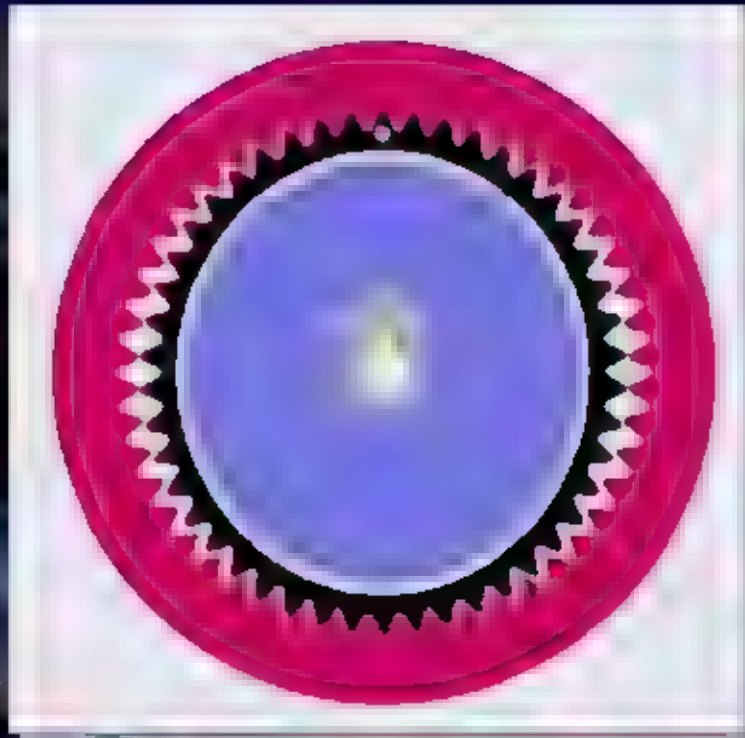
## VGRS System

- Reduction Mechanism
  - Operation of strain wave gearing



## **VGRS System**

- Reduction Mechanism
  - Operation of strain wave gearing



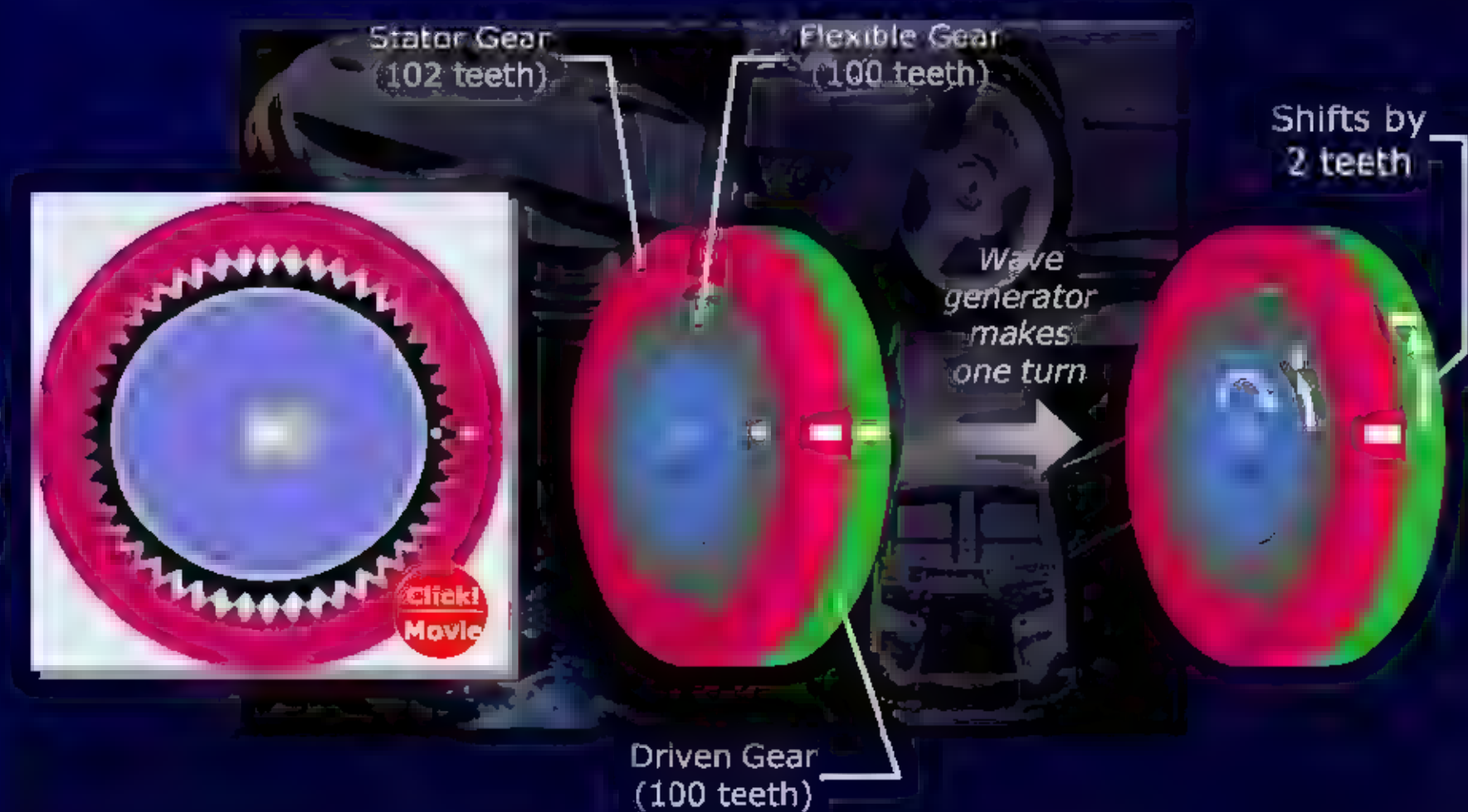
*Stator gear fixed*

View from stator gear side  
(Steering wheel side)



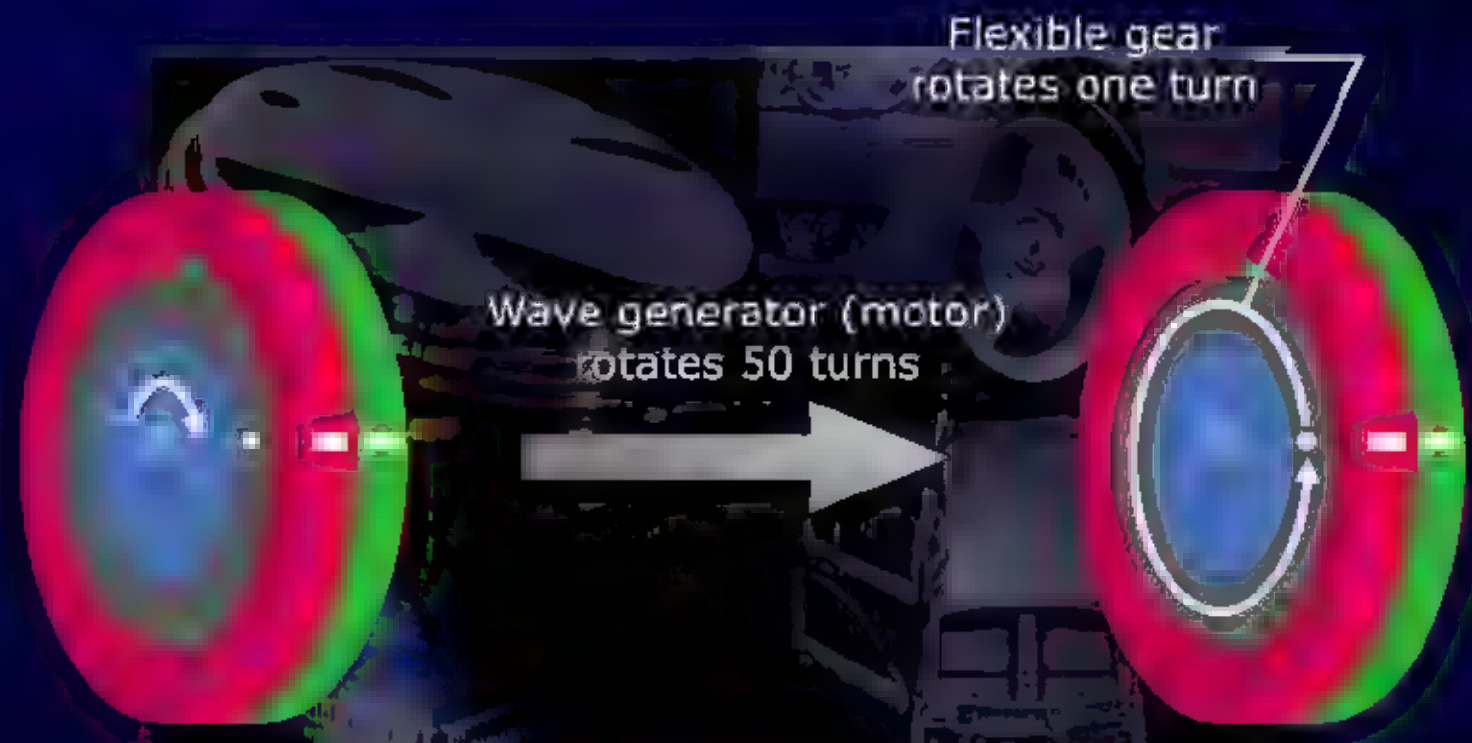
## VGRS System

- Reduction Mechanism
  - Operation of strain wave gearing



## VGRS System

- Reduction Mechanism
  - Reduction gear ratio



Gear Ratio	50	:	1
	Motor		Flexible Gear

- Operation
  - Vehicle speed is low (quick ratio)





## VGRS System

- Operation
  - Vehicle speed is mid. (normal ratio)



## VGRS System

- Operation
  - Vehicle speed is high (slow ratio)



## VGRS System

- Warning Message
  - VGRS warning message for the system malfunction





## **VGRS System**

- Diagnosis
  - 29 DTCs for VGRS system

DTC	Detection Item
C1591	VGRS Actuator Neutral Position Calibration Undone
C1592	VGRS Actuator Neutral Position Calibration Incomplete
C1593	VGRS Actuator Standard Position Malfunction
C1595	Lost Communication with Steering Angle Sensor Module
C1597	Lost Communication between VGRS and EPS
C15A1	VGRS Actuator Malfunction
C15A2	VGRS Actuator Malfunction
C15A3	VGRS Actuator Malfunction
C15A4	VGRS Actuator Malfunction
C15A5	VGRS Actuator Malfunction
C15A6	VGRS Actuator Malfunction
C15A9	Lock Holder Deviation Detection
C15AA	Lock Mechanism Release Incomplete
C15AB	Lock Mechanism Insertion Malfunction

## **VGRS System**

- Diagnosis
  - 29 DTCs for VGRS system

DTC	Detection Item
C15B1	VGRS ECU Malfunction
C15B2	VGRS ECU Malfunction
C15B3	VGRS ECU Malfunction
C15B4	VGRS ECU Malfunction
C15C1	Steering Angle Sensor Malfunction
C15C2	Steering Angle Sensor B+ Malfunction
C15C3	Brake System Control Module Malfunction
C15C6	IG Power Supply Voltage Malfunction
C15C7	DC Motor Power Source Voltage Malfunction
C15C8	Power Supply Relay Failure
U0100	Lost Communication With ECM/PCM "A"
U0122	Lost Communication With Vehicle Dynamics Control Module
U0123	Lost Communication With Yaw Rate Sensor Module
U0126	Lost Communication With Steering Angle Sensor Module
U0131	Lost Communication With Power Steering Control Module

## VGRS System

### ● Initialization and Calibration

Item	Steering Angle Sensor Initialization	Calibration
Replacement •VGRS ECU •VGRS Actuator	○	○
Repairing steering system parts		
Reconnect the battery terminal	○	✕
Reconnect the connectors •Steering Angle Sensor •VGRS ECU •VGRS Actuator •Skid Control ECU		

